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ORIGINAL ARTICLE

Lower dynamic strength index variability in competitive athletes than in regularly trained non-athletes: An exploratory cross-sectional study in a real gym setting

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ABSTRACT

The Dynamic Strength Index (DSI), the ratio of peak concentric force during a countermovement jump (CMJ) to peak vertical force during an isometric mid-thigh pull (IMTP), is an established diagnostic tool in high-performance sport, but its behaviour in mixed gym populations is poorly characterised. This exploratory cross-sectional study examined whether competitive athletes and regularly trained non-athletes differ in DSI central tendency, dispersion, or both. DSI, Peak Force IMTP, and Peak Concentric Force CMJ were compared between competitive athletes (n = 15) and regularly trained non-athletes (n = 15), aged 20–40 years, assessed on force platforms. Group means were compared with independent-samples t tests (with Welch's t test as a sensitivity analysis), and DSI dispersion with a variance ratio (F) test and the Brown–Forsythe test. No significant between-group difference was found in mean DSI (athletes: M = 0.730, SD = 0.103; non-athletes: M = 0.785, SD = 0.181; p = .312, d = −0.38). Peak Force IMTP (3017 vs. 2455 N; p = .081, d = 0.66) and Peak Concentric Force CMJ (2165 vs. 1815 N; p = .052, d = 0.74) showed effect size estimates favouring athletes that require confirmation in larger samples. DSI dispersion was lower in athletes (CV = 14.1% vs. 23.1%; F(14, 14) = 3.11, p = .042; Brown–Forsythe p = .034); the difference persisted after adjustment for sex but was sensitive to the two highest non-athlete values. This preliminary finding is compatible with, but does not demonstrate, a constraining effect of competitive training on the DSI; longitudinal research is required. In heterogeneous training populations, the DSI appears most informative when interpreted individually and alongside its component force values.

Keywords: performance analysis; dynamic strength index; isometric mid-thigh pull; countermovement jump; neuromuscular variability; force platforms; gym population.

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INTRODUCTION

The integration of maximal isometric force assessment with dynamic force expression has become a cornerstone of neuromuscular profiling in applied sport science. Measuring these capacities in isolation — through isometric contractions or vertical jump performance — provides useful but incomplete information. The Dynamic Strength Index (DSI) addresses this limitation by quantifying the relationship between an individual's isometric force ceiling and their capacity to express force under ballistic, time-constrained conditions (Sheppard et al., 2011).

The DSI is calculated as the ratio of peak concentric force during a countermovement jump (CMJ) to peak vertical force during an isometric mid-thigh pull (IMTP). Conceptually, it operationalises the force deficit originally described by Verkhoshansky — the proportion of isometric potential that cannot be transferred to dynamic actions (as cited in González Badillo & Gorostiaga Ayestarán, 1995). Sheppard et al. (2011) proposed reference ranges that continue to guide training prescription: DSI < 0.60 indicates maximal strength limitation, 0.60–0.80 reflects an intermediate profile, and DSI > 0.80 indicates that ballistic force expression is the limiting factor. McMahon et al. (2017) further demonstrated that DSI values are influenced by jump strategy, underscoring the importance of interpreting the index alongside absolute force values.

The psychometric properties of the DSI are well established. Thomas et al. (2015) reported ICC ≥ .92 and CV ≤ 4.6% in collegiate athletes. Comfort et al. (2018) confirmed near-perfect reliability for all component variables (ICC ≥ .970; CV ≤ 4.69%). Despite this, the DSI literature has been almost exclusively confined to competitive athletes — predominantly male, university-level, team-sport populations (Comfort et al., 2018; McMahon et al., 2017; Thomas et al., 2015; Thomas et al., 2017). As Joksimović et al. (2025) noted, the DSI holds promise as a diagnostic tool in broader training contexts, yet evidence in non-athlete populations remains scarce.

From a theoretical perspective, DSI sits at the intersection of several established frameworks in motor control and sport science. The constraints-led approach (Newell, 1986) proposes that movement emerges from the interaction of organismic, environmental, and task constraints. Systematic training can be viewed as an organismic constraint that may narrow the range of viable neuromuscular solutions and stabilise coordination patterns over time. Under this framework, athletes exposed to repeated, structured competitive demands might be expected to exhibit more consistent DSI profiles than non-athletes, whose force-expression strategies may remain more variable. Complementarily, motor variability theory (Bernstein, 1967; Davids et al., 2008) distinguishes between functional and dysfunctional variability. Finally, the strength-power continuum model (Haff & Nimphius, 2012) frames force expression as a spectrum from slow, maximal isometric contractions to rapid, ballistic movements — a continuum that DSI directly quantifies.

In real gym environments, practitioners routinely collect IMTP and CMJ data from heterogeneous populations that include both competitive athletes and regularly trained non-athletes with highly variable strength profiles. Whether the DSI behaves similarly across these groups is not well understood. The present exploratory study describes and compares DSI, Peak Force IMTP, and Peak Concentric Force CMJ between athletes and non-athletes evaluated in a real gym setting. It was hypothesised that athletes and non-athletes would show similar group-level DSI means but different intra-group dispersion — a pattern that would be compatible with, although in a cross-sectional design not demonstrative of, training constraining DSI variability. Group membership was defined by competitive participation status; it is therefore a categorical indicator of competitive participation rather than a direct, quantitative measure of training exposure.

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MATERIAL AND METHODS

Participants

Thirty participants (15 athletes, 15 non-athletes; 17 males, 13 females) aged 20–40 years were recruited from a private performance and rehabilitation centre in Buenos Aires, Argentina. All 30 participants completed both tests (IMTP and CMJ) and all 30 were included in the analysis; no participant was excluded. Athletes were operationally defined as individuals who had participated in at least one regulated (officially sanctioned) sports competition in the preceding 12 months (sports represented: football, rugby, field hockey, basketball, and volleyball). Non-athletes were defined as individuals maintaining regular structured training without participation in regulated competition in the same period. This classification reflects competitive participation status rather than a quantitative measure of training volume or exposure, and the athlete group included five sports with potentially different strength and ballistic demands. Both sexes were included in each group without stratification; sex distribution across groups was: athletes (10 males, 5 females), non-athletes (7 males, 8 females). Sex-specific descriptive values are reported as exploratory information (Table 5). All participants provided informed consent prior to testing. Data were fully anonymised; participants are reported in aggregate only.

Measures

Force data were collected using VALD force platforms (VALD Performance, Brisbane, Australia), processed and stored in VALD Hub. Three dependent variables were analysed: Peak Vertical Force IMTP (N), Peak Concentric Force CMJ (N), and the DSI ratio.

Procedures

All testing was conducted in a single session per participant at the same facility by the same evaluator, following standardised protocols.

Isometric Mid-Thigh Pull. Each participant completed joint mobilisation and three progressive IMTP repetitions (50%, 75%, 100% of subjective maximum, 3 s each). Participants were positioned on the force platforms with knee angles of 130°–140° and hip angle of approximately 145°, gripping a fixed barbell with pronated grip assisted by lifting straps. A pre-tension of approximately 20% was applied and sustained until the start of the pull. Verbal instruction: "Push the floor as hard and as fast as you can, without losing tension." Three trials of 3 s were performed with 30 s of passive recovery. Trials showing technique errors (bar release or loss of grip, joint extension, pre-tension loss, trunk inclination, ramp force application) or reported by the participant as not maximal (e.g., because of fatigue) were considered invalid and repeated after the same recovery period, so that each participant completed three valid trials. As a reproducibility criterion, the coefficient of variation (CV) of peak force was calculated across each participant's three valid trials; a test with CV > 10% was to be excluded (Haff et al., 2015). In the present sample, all participants met this criterion and no test was excluded. The dependent variable was Peak Vertical Force (N).

Countermovement Jump. Warm-up consisted of joint mobilisation and three sets of three CMJ repetitions. Participants stood on force platforms with hands on hips and remained stationary for ≥ 1 s for body weight measurement. Verbal instruction: "Jump as fast and as high as you can." Three jumps were performed with 20 s of passive recovery. Trials showing double contact, arm movement, slow controlled descent, off-platform landing, or two-step landing, or reported by the participant as not maximal, were considered invalid and repeated, so that each participant completed three valid trials. The same reproducibility criterion (CV of peak concentric force across the three valid trials ≤ 10%) was applied (Haff et al., 2015), and no test was excluded. The dependent variable was Peak Concentric Force (N), defined as maximum vertical force during the

propulsion phase. Jump strategy was not systematically recorded beyond the standardised instruction; this is acknowledged as a potential source of variability and is addressed in the limitations.

DSI Calculation. The DSI was calculated for each participant as:

$$\text{DSI} = \text{Peak Concentric Force CMJ (N)} / \text{Peak Vertical Force IMTP (N)}$$

The highest valid trial value was used for each test. This choice was made because the DSI is defined as a ratio of peak force capacities (Sheppard et al., 2011), and the highest valid value represents the upper limit of each capacity; it is also consistent with common applied practice (Comfort et al., 2018; Thomas et al., 2015). Because the numerator and denominator were selected independently, they may derive from trials with different technical or biological variation; this is acknowledged as a limitation. Trial-level values were not retained in the analysed dataset; therefore, within-session reliability could not be quantified in the present sample beyond the CV ≤ 10% eligibility criterion.

Two non-athletes presented DSI values above 1.00 (1.048 and 1.117). Because these values are mathematically possible but uncommon, both observations were verified against the original force-platform records in VALD Hub. In one participant, the DSI above 1.00 coincided with a very low relative IMTP peak force (≈ 17 $N \cdot kg^{-1}$) rather than an unusually high CMJ peak concentric force. In the other participant, a later assessment in which both tests were performed on the same day again yielded a DSI above 1.00 (1.06), indicating that the value reflects the participant's force profile rather than a recording artefact. No exclusion was warranted, and both observations were retained in all primary analyses; their influence was examined in a sensitivity analysis.

Statistical analysis

Data are presented as means (*M*) and standard deviations (*SD*) and coefficient of variation (CV, expressed as a percentage). Normality was assessed with the Shapiro–Wilk test applied to the observations within each group, separately for each variable (for a two-group comparison this is equivalent to examining the residuals of the group model). Group means were compared with independent-samples (Student's) *t* tests and, as a sensitivity analysis not assuming equal variances, Welch's *t* test. Because the central hypothesis concerned intra-group dispersion rather than central tendency, homogeneity of DSI variance between groups was examined with a variance ratio (*F*) test, with the 95% confidence interval for the ratio of variances reported, and, as a robust sensitivity analysis, with the Brown–Forsythe test (Levene's test centred on the median). To examine whether the unequal sex composition of the groups could account for the dispersion difference, DSI was regressed on group and sex, and the Brown–Forsythe test was repeated on the sex-adjusted residuals. A further sensitivity analysis repeated the dispersion tests after excluding the two DSI values above 1.00. DSI values by sex within each group are reported descriptively, without inferential testing, given the small subgroups. Effect sizes were calculated using Cohen's *d* (small: 0.2; medium: 0.5; large: 0.8) with 95% confidence intervals (Cumming, 2014; Lakens, 2013). Statistical significance was set at $p < .05$. DSI profile distributions according to Sheppard et al. (2011) were reported descriptively. Primary analyses were conducted using JASP (Version 0.19; JASP Team, 2024); sensitivity analyses were conducted in Python with SciPy (Version 1.18; Virtanen et al., 2020).

RESULTS

Within-group Shapiro–Wilk tests did not indicate departures from normality for any variable (all $p \geq .19$; Table 2). Descriptive statistics, effect sizes, and inferential results are presented in Table 1 and Table 2. DSI profile

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distribution is presented in Table 3, sensitivity analyses in Table 4, and exploratory sex-specific DSI values in Table 5.

No statistically significant difference was found in DSI between athletes (*M* = 0.730, *SD* = 0.103; CV = 14.1%) and non-athletes (*M* = 0.785, *SD* = 0.181; CV = 23.1%; *t*(28) = −1.03, *p* = .312, *d* = −0.38, 95% CI [−1.10, 0.35]). Peak Force IMTP was higher in athletes (*M* = 3017 N, *SD* = 739 N) than non-athletes (*M* = 2455 N, *SD* = 948 N), without reaching statistical significance (*t*(28) = 1.81, *p* = .081, *d* = 0.66, 95% CI [−0.07, 1.40]). A similar pattern was observed for Peak Concentric Force CMJ (athletes: *M* = 2165 N, *SD* = 455 N; non-athletes: *M* = 1815 N, *SD* = 492 N; *t*(28) = 2.03, *p* = .052, *d* = 0.74, 95% CI [0.00, 1.48]). Welch's *t* tests led to the same conclusions (DSI: *t*(22.2) = −1.03, *p* = .314; Peak Force IMTP: *t*(26.4) = 1.81, *p* = .082; Peak Concentric Force CMJ: *t*(27.8) = 2.03, *p* = .052). The effect size estimates for Peak Force IMTP and Peak Concentric Force CMJ suggest potentially meaningful differences favouring athletes; however, their confidence intervals include values close to zero and the study was not prospectively powered for these comparisons, so these differences require confirmation in a larger, prospectively powered sample. The DSI effect (*d* = −0.38) was small.

Table 1. Descriptive statistics by group for all dependent variables.

Variable	Group	*n*	*M*	*SD*	CV (%)	Cohen's *d* (95% CI)
DSI	Athlete	15	0.730	0.103	14.1	−0.38 [−1.10, 0.35]
DSI	Non-athlete	15	0.785	0.181	23.1	
Peak Force IMTP (N)	Athlete	15	3017	739	24.5	0.66 [−0.07, 1.40]
Peak Force IMTP (N)	Non-athlete	15	2455	948	38.6	
Peak Concentric Force CMJ (N)	Athlete	15	2165	455	21.0	0.74 [0.00, 1.48]
Peak Concentric Force CMJ (N)	Non-athlete	15	1815	492	27.1	

Note. *SD* = standard deviation; CV = coefficient of variation (*SD*/mean × 100). Cohen's *d* reported for between-group comparison (Athlete − Non-athlete).

Table 2. Within-Group Shapiro–Wilk Normality tests and between-group comparisons of means.

Variable	Shapiro–Wilk *W* (*p*), athletes	Shapiro–Wilk *W* (*p*), non-athletes	Student *t* (*df* = 28)	*p*	Welch *t* (*df*)	*p*
DSI	.935 (.321)	.951 (.538)	−1.03	.312	−1.03 (22.2)	.314
Peak Force IMTP (N)	.942 (.403)	.956 (.630)	1.81	.081	1.81 (26.4)	.082
Peak Concentric Force CMJ (N)	.920 (.194)	.954 (.596)	2.03	.052	2.03 (27.8)	.052

Note. Shapiro–Wilk tests were applied to the observations within each group. Welch's *t* test does not assume equal variances.

Table 3. Distribution of participants by DSI Profile (Sheppard et al., 2011).

DSI Profile	Range	Athletes (*n*)	Non-athletes (*n*)
Maximal strength-limited	< 0.60	3	2
Intermediate	0.60–0.80	7	7
Ballistic force expression-limited	> 0.80	5	6

Note. *n* = number of participants per profile and group.

Intra-Group DSI variability

The most novel finding concerns intra-group variability. DSI dispersion was lower in athletes (CV = 14.1%) than in non-athletes (CV = 23.1%); the non-athlete CV was approximately 1.64 times the athlete CV. The ratio of variances was approximately 3.11 (*F*(14, 14) = 3.11, *p* = .042, 95% CI for the ratio of variances [1.04, 9.25]). The Brown–Forsythe test led to the same conclusion (*F*(1, 28) = 4.99, *p* = .034), as did the test on sex-adjusted residuals (*F*(1, 28) = 5.05, *p* = .033), and within each sex DSI dispersion was lower in athletes than in non-athletes (males: CV = 13.9% vs. 28.2%; females: CV = 14.3% vs. 19.7%; Table 5). However, the result was sensitive to the upper tail of the non-athlete distribution: when the two DSI values above 1.00 were excluded, the difference in dispersion was no longer statistically significant (*F*(12, 14) = 2.00, *p* = .218; Brown–Forsythe *p* = .127; Table 4). Given this sensitivity and the wide confidence interval for the variance

ratio, which reflects the small number of participants per group, the finding should be regarded as preliminary evidence rather than confirmation of a stable population difference. Figure 1 displays each participant's observed DSI value together with normal distribution curves parameterised from the observed group means and standard deviations.

Table 4. Comparison of DSI dispersion between groups: Primary and sensitivity analyses.

Analysis	Test	Statistic	*p*	Note
Primary (*n* = 15 vs. 15)	Variance ratio (*F*)	*F*(14, 14) = 3.11	.042	95% CI for ratio of variances [1.04, 9.25]
Primary (*n* = 15 vs. 15)	Brown–Forsythe	*F*(1, 28) = 4.99	.034	Levene (mean-centred): *F*(1, 28) = 5.00, *p* = .033
Adjusted for sex	Brown–Forsythe on residuals of DSI ~ group + sex	*F*(1, 28) = 5.05	.033	Residual variance ratio = 3.18
Excluding the two DSI values > 1.00 (*n* = 15 vs. 13)	Variance ratio (*F*)	*F*(12, 14) = 2.00	.218	Non-athlete CV = 19.6%
Excluding the two DSI values > 1.00 (*n* = 15 vs. 13)	Brown–Forsythe	*F*(1, 26) = 2.48	.127	

Note. The Brown–Forsythe test is Levene's test centred on the median. Sensitivity analyses were conducted in Python with SciPy (Version 1.18; Virtanen et al., 2020).

Table 5. Exploratory DSI descriptive values by sex within each group.

Group	Sex	*n*	*M*	*SD*	CV (%)	Range
Athlete	Male	10	0.749	0.104	13.9	0.591–0.878
Athlete	Female	5	0.692	0.099	14.3	0.565–0.832
Non-athlete	Male	7	0.766	0.216	28.2	0.543–1.117
Non-athlete	Female	8	0.802	0.158	19.7	0.620–1.048
All	Male	17	0.756	0.154	20.4	
All	Female	13	0.760	0.145	19.1	

Note. Descriptive only; no inferential testing was performed given the small subgroup sizes.

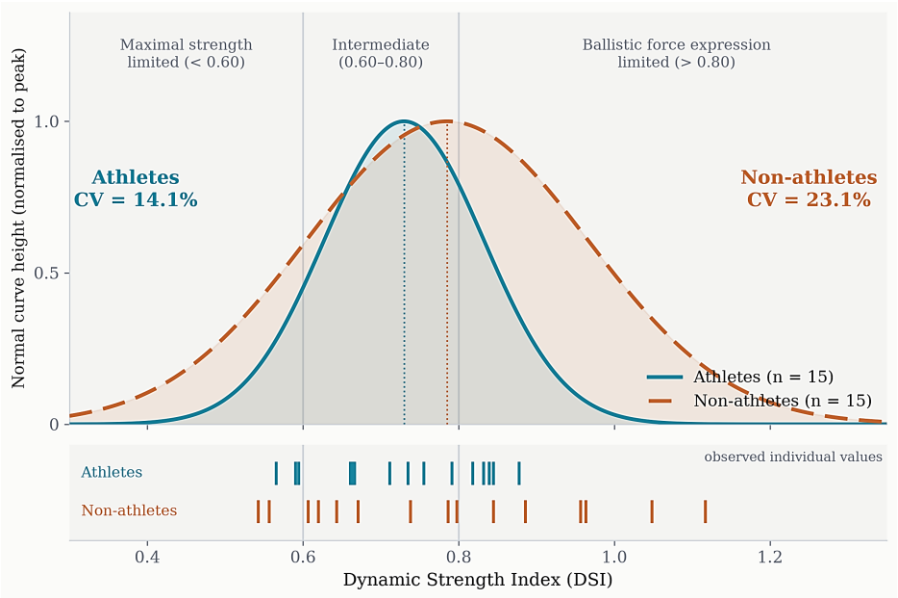


Figure 1. DSI values in athletes and non-athletes. Smooth lines are normal distribution curves parameterised from the observed group means and standard deviations (athletes: *M* = 0.730, *SD* = 0.103; non-athletes: *M* = 0.785, *SD* = 0.181), normalised to their peaks for visual comparison; they are not empirical density estimates. Tick marks beneath the plot show each participant's observed DSI value. CV = 14.1% (athletes) vs. 23.1% (non-athletes). Background shading indicates DSI profile classifications (Sheppard et al., 2011). Variance ratio test: *F*(14, 14) = 3.11, *p* = .042; Brown–Forsythe test: *F*(1, 28) = 4.99, *p* = .034.

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Regarding DSI profile distribution (Table 3), both groups concentrated in the intermediate range (0.60–0.80): seven athletes and seven non-athletes. Three athletes and two non-athletes presented a maximal strength-limited profile (DSI < 0.60), while five athletes and six non-athletes fell in the ballistic force expression-limited range (DSI > 0.80).

DISCUSSION

The primary finding of this study was the absence of statistically significant between-group differences in mean DSI, despite effect size estimates favouring athletes in both absolute force variables. Taken together, the findings are compatible with the view that the DSI may be more informative as an indicator of the consistency of neuromuscular organisation than as a measure of performance level; this interpretation, however, requires longitudinal confirmation.

Both groups produced mean DSI values within the intermediate range (Sheppard et al., 2011): athletes at 0.730 and non-athletes at 0.785. This absence of group differences is consistent with Thomas et al. (2017), who found that DSI differences in a large athlete sample were more strongly associated with sex than with sport classification. In the present study, exploratory sex-specific values showed similar mean DSI in males (0.756) and females (0.760) overall (Table 5); nevertheless, the lack of sex stratification may have introduced within-group variability that could mask a true between-group difference — a methodological consideration future studies should address through stratified designs or mixed-model analyses.

The most substantive finding is the difference in intra-group dispersion: the non-athlete CV was approximately 1.64 times that of athletes, and this was the only between-group difference that reached statistical significance. It was supported by the Brown–Forsythe test and persisted after adjustment for sex, but it was sensitive to the two highest non-athlete DSI values. Because the design is cross-sectional, this finding cannot establish that systematic sport practice produced the lower dispersion. A plausible theoretical interpretation, consistent with the constraints-led approach (Newell, 1986), is that competitive training acts as an organismic constraint that narrows the range of neuromuscular solutions and stabilises the relationship between isometric force capacity and ballistic force expression. Alternative explanations are, however, equally compatible with the data, including selection into competitive sport, sport-specific recruitment, differences in training history, jump strategy, or other unmeasured characteristics. From a motor variability perspective (Bernstein, 1967; Davids et al., 2008), the greater dispersion among non-athletes could reflect less constrained force-expression strategies, but the present data do not allow functional and dysfunctional variability to be distinguished. Longitudinal research is required to determine whether training reduces DSI dispersion.

The trends observed for Peak Force IMTP (p = .081, d = 0.66) and Peak Concentric Force CMJ (p = .052, d = 0.74) are in the direction expected from the literature associating competitive sport participation with greater force capacities (Comfort et al., 2018; Suchomel et al., 2016). These estimates suggest potentially meaningful differences, but their confidence intervals include effects close to zero and the study was not prospectively powered for these comparisons. The high within-group heterogeneity, particularly the non-athlete CV of 38.6% for IMTP, contributes to this imprecision. Confirmation in a larger, prospectively powered and sex-stratified sample is required.

The athlete group's DSI dispersion (range: 0.565–0.878) is comparable to inter-sport variation reported by Thomas et al. (2017), who found values ranging from 0.70 in male football to 0.91 in female cricket within a single athlete sample. The present athlete group encompassed five different sports, each imposing distinct

neuromuscular demands. Moreover, group membership reflects competitive participation status rather than a quantitative measure of training exposure, which limits the degree to which the observed dispersion can be attributed specifically to the organisation imposed by competitive training. Future work should stratify by sport or cluster disciplines by predominant neuromuscular demand, and quantify training exposure directly.

From a practical standpoint, the results support interpreting the DSI individually and alongside its component force values, particularly in mixed populations. The wide within-group dispersion, especially among non-athletes, suggests that reference ranges derived from athletic samples may not describe recreationally trained individuals well, although classification accuracy against an external criterion was not evaluated in this study. As a practice-oriented inference consistent with these findings — rather than an effect demonstrated by this dataset, which did not evaluate longitudinal monitoring, training prescription, or responsiveness to intervention — practitioners in fitness and conditioning settings may consider establishing individual DSI baselines and always interpreting profile classifications alongside absolute IMTP and CMJ values, since the ratio can be identical across individuals whose constituent force values differ substantially (Suchomel et al., 2020).

Limitations include the small sample size, absence of sex stratification, heterogeneity of sports within the athlete group, the use of competitive participation status rather than a quantitative measure of training exposure, the cross-sectional design, and lack of systematic jump strategy characterisation. Regarding jump strategy specifically: countermovement depth and descent velocity were not recorded, and differences in strategy between groups could bias CMJ peak concentric force values independently of actual force production capacity (Van Hooren & Zolotarjova, 2017). Integration of force-time curve analysis in future work would allow disentangling strategy effects from true neuromuscular capacity differences. The highest valid trial was selected independently for each test, so the numerator and denominator of the DSI may derive from trials with different technical or biological variation. Regarding the dispersion analysis, the classical *F* test is sensitive to departures from normality; although within-group Shapiro–Wilk tests did not indicate such departures and the Brown–Forsythe test led to the same conclusion, the difference depended on the two highest non-athlete DSI values and the confidence interval for the variance ratio was wide. Future studies should employ larger stratified samples, conduct a priori power analyses, include force-time curve analysis, and adopt longitudinal designs to examine whether the lower dispersion observed here is a product of training or a selection effect.

CONCLUSIONS

The DSI did not differ significantly between competitive athletes and regularly trained non-athletes evaluated in a real gym setting. Lower intra-group DSI dispersion was observed among athletes (CV = 14.1% vs. 23.1%; $F(14, 14) = 3.11$, $p = .042$; Brown–Forsythe $p = .034$). This preliminary, cross-sectional finding is compatible with — but does not demonstrate — a constraining effect of competitive training, and could also reflect selection into sport or other unmeasured characteristics; moreover, it was sensitive to the two highest non-athlete values. Both groups concentrated in the intermediate DSI profile (0.60–0.80). Effect size estimates for absolute force variables favoured athletes but require confirmation in larger samples. In heterogeneous gym populations, the DSI appears most useful when interpreted individually and alongside its component force values. Future work should use larger, sex-stratified samples, conduct a priori power analyses, and follow participants longitudinally to determine whether lower DSI dispersion is produced by training or reflects selection.

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CONFLICT OF INTEREST

The author declares no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

ETHICS APPROVAL AND INFORMED CONSENT

The study was conducted with the authorisation of the institution where the data were collected (a private performance and rehabilitation centre in Buenos Aires, Argentina; Grupo Agile Kinesiología, Buenos Aires, Argentina), which approved the use of anonymised, routinely collected assessment data for research and publication. The data analysed were obtained during routine neuromuscular assessments forming part of the standard performance evaluation practice of the centre at which participants trained; no experimental intervention, manipulation, or additional procedure was introduced for research purposes, and participants were exposed to no risk beyond that of the routine testing they would have undergone regardless of this study. On this basis, and with the institution's authorisation, review by a research ethics committee was not sought. Personal data were handled in accordance with the Argentine Personal Data Protection Law (Law No. 25,326), and all data were fully anonymised prior to analysis and are reported in aggregate only. All procedures were conducted in accordance with the ethical principles for research involving human participants set out in the Declaration of Helsinki (World Medical Association, 2013).

Written informed consent was obtained from all participants prior to testing, covering both the assessment procedures and the anonymised use of their data for analysis and publication. All participants were adults aged 20–40 years; parental or guardian consent was therefore not applicable. No individually identifiable data are reported.

DATA AVAILABILITY STATEMENT

The anonymised dataset supporting the findings of this study is available from the author upon reasonable request. The data are not deposited in a public repository because the informed consent obtained from participants covered the anonymised use of their data for analysis and publication but did not extend to open repository deposition.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The author retains full responsibility for the content of the manuscript and confirms its originality, integrity, and accuracy.

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